CLAIMS

1. A method of monitoring a birth process, comprising:

receiving, over time, a plurality of position signals from one or more positioning elements or tissue areas located at at least one of a cervix and a fetal head; and

determining a discrete state of labor of a fetus that is wholly inside a body responsive to said position signals, with a temporal resolution of better than 15 minutes, said discrete state being other than a start or stop of labor and encompassing more than a single contraction, said state including a state other than an abnormal fetal head position.

2. A method according to claim 1, wherein said one or more positioning elements comprises a wireless transponder.

3. A method according to claim 1, wherein receiving comprises receiving from one or more tissue areas identifiable using an imaging system.

4. A method according to claim 1, wherein receiving comprises receiving from at least one positioning element.

5. A method according to claim 1, wherein said one or more positioning elements comprises a transmitter.

6. A method according to claim 1, wherein said one or more positioning elements comprises a marker.

7. A method according to claim 1, wherein said discrete state comprises at least one state from a list of states including: failure to progress, inefficient uterine contractions, onset of active labor, full dilatation, optimal uterine activity, individual maximum slope of dilatation, fetal head internal rotation, fetal head extension, pre-cresting, arrest disorder, canal arrest, abnormal expulsion contractions, normal expulsion contractions, efficacy of drug administration and readiness for delivery.

8. A method according to claim 7, comprising determining at least 2 states from said list at different times.

9. A method according to claim 7, comprising determining at least 4 states from said list at different times.

10. A method according to claim 7, comprising determining at least 6 states from said list at different times.

11. A method according to claim 1, wherein the position signals comprises fetal head position signals and cervical OS position signals.

12. A method according to claim 1, wherein the position signals do not comprise absolute cervical dilatation signals.

13. A method according to claim 1, wherein the position signals comprise absolute cervical dilatation signals.

14. A method according to claim 13, comprising modifying the cervical dilatation signals to reflect a scale on which full dilatation is 10 cm.

15. A method according to claim 1, wherein determining comprises determining based on an analysis of short term changes in said signals, within a time period of a contraction cycle.

16. A method according to claim 15, wherein said analysis comprises an analysis of changes in a fetal head position.

17. A method according to claim 16, wherein said analysis comprises an analysis of a spatial vector of fetal head motion.

18. A method according to claim 15, wherein said analysis comprises an analysis of changes in cervical geometry.

19. A method according to claim 15, wherein said analysis comprises an analysis of rate of change of a position.

20. A method according to claim 15, wherein said analysis comprises an analysis over a plurality of contractions.

21. A method according to claim 13, wherein said determining comprises determining based on a duty factor of a plurality of contractions.

22. A method according to claim 1, wherein said determining comprises determining that a labor is progressing normally.

23. A method according to claim 1, wherein said determining comprises determining that a labor is progressing abnormally.

24. A method according to claim 1, wherein said determining comprises determining a type of contraction.

25. A method according to claim 1, wherein said determining is based on non-geometrical physiological signals of at least one of mother and fetus.

26. A method according to claim 25, wherein said determining comprises analyzing a phase delay between non-geometric physiological and geometrical measurements.

27. A method according to claim 25, wherein said physiological signals comprise pressure signals.

28. A method according to claim 25, wherein said physiological signals comprise EMG signals.

29. A method according to claim 25, wherein said physiological signals comprise heart rate signals.

30. A method according to claim 1, wherein determining comprises determining a state on a personalized time/progression scale.

31. A method according to claim 1, comprising matching a progression of labor to one of a plurality of templates.

32. A method according to claim 1, comprising estimating a time to reach a future state, based on said signals.

33. A method according to claim 1, wherein said position signals are acquired using a reference remote from said elements.

34. A method according to claim 1, comprising determining at least one of an orientation change and magnitude change in a vector of a fetal head.

35. A method according to claim 34, wherein said change in vector comprises a change in orientation of a fetal head.

36. A method according to claim 34, comprising generating a head station value indicating the spatial progression of the fetal head in a birth canal.

37. A method according to claim 34, wherein said vector comprises a vector of motion of said head during a contraction.

38. A method according to claim 37, comprising comparing said vector to an expected head path in a maternal body.

39. A method according to claim 37, comprising determining an asymmetry between forward motion and backward motion of said head.

40. A method of labor management, comprising:

(a) collecting information about a labor process;

(b) generating a personalized progression representation based on said information;

(c) identifying a relationship between a parameter of said representation and a norm, within 20 minutes of said parameter changing its relationship relative to the norm; and

(d) selectively modifying a treatment of the labor responsive to said identification.

41. A method according to claim 40, wherein said identifying comprises identifying by computer circuitry.

42. A method according to claim 40, comprising suggesting a modification by computer circuitry.

43. A method according to claim 40, wherein identifying comprises identifying that said parameter is outside a norm.

44. A method according to claim 40, wherein identifying comprises identifying that said parameter is inside a norm.

45. A method according to claim 40, wherein selectively modifying comprises not modifying.

46. A method according to claim 40, wherein generating said personalized progression representation comprises statistical analysis of said collected information.

47. A method according to claim 46, wherein said statistical analysis comprises long term analysis.

48. A method according to claim 46, wherein said statistical analysis comprises short-term analysis.

49. A method according to claim 46, wherein said statistical analysis comprises generating a histogram.

50. A method according to claim 40, wherein said personalized progression representation includes an expected rate of change.

51. A method according to claim 40, wherein said personalized progression representation includes an identification of at least three labor states.

52. A method according to claim 40, wherein said personalized progression representation comprises an indication that an individual maximum slope is about to be achieved.

53. A method according to claim 52, wherein said indication comprises a dedicated display.

54. A method according to claim 40, wherein said indication comprises a state display including a presentation of states according to their relative context and including a history of states.

55. A method according to claim 40, wherein said indication comprises a display of individual maximum slope.

56. A method of monitoring a labor process, comprising:

receiving, over time, a plurality of positional information from one or more positioning elements or tissue segments located at at least one of a cervix and a fetal head;

determining at least one change in magnitude of positional information within a contraction;

analyzing said at least one change; and

determining a status of said labor based on said analysis.

57. A method according to claim 56, comprising analyzing over a plurality of contractions to yield a composite indication used in said determining.

58. A method according to claim 56, wherein said analysis comprises maximum change analysis.

59. A method according to claim 56, wherein said analysis comprises rate of change analysis.

60. A method according to claim 56, wherein said analysis comprises analysis of cervical dilatation.

61. A method according to claim 56, wherein said analysis comprises analysis of fetal head position.

62. A method according to claim 56, wherein said analysis comprises analysis of a duty factor of the contraction based on changes in position.

63. A method according to claim 56, wherein determining a state comprises determining a discrete state.

64. A method according to claim 56, comprising displaying said analysis in a graphical form.

65. A method according to claim 64, wherein said graphical form shows results for at least two hours of said labor.

66. A method according to claim 64, wherein said graphical form shows results for at least half an hour of said labor.

67. A method according to claim 64, wherein said graphical form shows results for at least 10 contractions.

68. A method according to claim 64, wherein said graphical form shows results for at least 30 contractions.

69. A method according to claim 56, wherein determining comprises determining based on non-geometric physiological information.

70. A method according to claim 56, wherein determining comprises determining based on long term net progression between contractions.

71. A method according to claim 56, comprising generating an indication of an effectiveness of said contraction.

72. A method according to claim 71, comprising generating an indication of an effectiveness of a drug titrated in said labor.

73. A method according to claim 71, comprising generating an instruction to a mother regarding pushing based on said indication.

74. A method according to claim 56, comprising normalizing said change based on measurements from a current labor.

75. A method according to claim 56, comprising normalizing said change based on a currently identified state of said labor.

76. A method of reporting a cervical condition, comprising:

measuring a cervical dilatation; and

modifying said measurement other than by sensor calibration to generate a different dilatation value smaller than or equal to 10 cm.

77. A method according to claim 76, wherein said modifying comprises correcting said measurement to reflect a human nomenclature where 10 cm indicates full dilatation.

78. A method according to claim 76, wherein said modifying is applied only for measurements larger than 5 cm.

79. A method according to claim 76, wherein said modifying is applied based on a detection of fetal head cresting.

80. A method according to claim 76, wherein said correction comprises a correction for the compliance of the cervix.

81. A method according to claim 76, wherein said correction is personalized to correct for a bias of a practitioner making the measurements.

82. A method according to claim 76, wherein said correction is personalized per patient.

83. A method of detecting full dilatation of a cervix, comprising:

measuring a relative position of a cervix and a reference point; and

determining full dilatation when said cervix moves relative to the reference point in accordance with a predetermined motion.

84. A method according to claim 83, wherein the reference point comprises a fetal head.

85. A method according to claim 84, wherein determining comprises detecting that said cervix crests over said fetal head.

86. A method according to claim 84, wherein said relative positions are determined relative to a virtual point in space, distanced from said head and cervix and in a direction of motion of the fetal head.

87. A method according to claim 83, wherein the suitable manner comprises retrograde motion of said cervix.

88. A method of determining a relative position of a point on a fetal head and a point on a cervix, comprising:

determining distances of the points from a reference location distanced from the sensors and in a general direction of an expected motion of said fetal head; and

determining relative values of the distances.

89. A method according to claim 88, comprising determining effacement of a cervix based on motion relative to said reference point.

90. A method according to claim 88, comprising detecting cresting of said fetal head based on motion relative to said reference point.

91. A method according to claim 88, comprising not reconstructing a plane of an opening of said cervix os.

92. A method of monitoring a labor process, comprising:

collecting geometrical information about an effect of a contraction;

collecting non-geometric physiological information about an effect of a contraction; and

correlating the collected geometric and non-geometric information.

93. A method according to claim 92, wherein correlating comprises displaying in a same time line.

94. A method according to claim 93, comprising displaying labor events in the same time line.

95. A method according to claim 92, wherein correlating comprises determining a phase difference between the non-geometric and geometrical information.

96. A method according to claim 92, wherein said geometric information comprises changes in geometrical information within a contraction cycle.

97. A method according to claim 92, wherein said geometric information comprises cervical dilatation and fetal head position.

98. A method according to claim 97, comprising presenting one of geometric information and non-geometric information as a function of the other.

99. A method according to claim 98, comprising presenting the informations in histogram form.

100. A method according to claim 97, comprising gating one of geometric information and non-geometric information as a function of the other.

101. A method according to claim 92, comprising presenting the informations in strip form.

102. A method according to claim 92, comprising presenting the informations as an overlay of information from different contractions.

103. A method according to claim 92, comprising presenting the informations in three-dimensional form.

104. A method of detecting a potential fetal head deformation, comprising:

detecting a putative head descent condition;

detecting a cervical dilatation value;

determining a mismatch between the head descent and the cervical dilatation value; and

determining a deformation based on said mismatch.

105. A method according to claim 104, wherein said cervical dilatation value is a less than full dilatation.

106. A method according to claim 104, wherein said cervical dilatation is determined to be a pre-cresting state.

107. A method according to claim 104, wherein said detecting a condition and said detecting a value comprise detecting using an attached positioning element.

108. Apparatus for detecting an onset of second stage of labor by cervical retrograde motion, comprising:

(a) an engager adapted to engage a Cervical os; and

(b) a body coupled to said engager and adapted to show a retraction of said engager relative to a body of a patient.

109. Apparatus according to claim 108, wherein said body is elongate enough to extend outside of a patient when attached to cervix os.

110. Apparatus according to claim 108, comprising an audible alarm activated upon detection of said retraction.

111. Apparatus according to claim 108, wherein said body includes a ruler.

112. Apparatus according to claim 111, wherein said ruler is adapted for calibration of initial position of said cervix.

113. Apparatus according to claim 108, comprising a mark of an initial position of said body.

114. A method of estimating changes in a cervical os, comprising:

(a) collecting positional information from at least one of a positioning element located on a fetal head and a positioning element located on the cervical os; and

(b) analyzing the positional information to yield an estimate of a cervical os property other than dilatation.

115. A method according to claim 114, wherein said analyzing comprises estimating an effacement from a degree of fetal head motion.

116. A method according to claim 114, wherein said analyzing comprises estimating a resiliency by comparing a change in cervical dilatation to a strength of a contraction.

117. A method according to claim 116, wherein said strength is measured using an IUP (intra-uterine pressure) sensor.

118. A method according to claim 114, wherein said analyzing comprises comparing a machine measurement of cervical dilatation to a human estimate of cervical dilatation.

119. A method according to claim 114, wherein said analyzing comprises determining rotation of a cervical positional element.

120. A method according to claim 114, wherein said collecting comprises collecting during an intervention.

121. A method according to claim 120, wherein said intervention comprises a manual examination.

122. A method of filtering geometrical labor information, comprising:

(a) providing a stream of geometrical information from a labor process; and

(b) filtering the stream using a filter that rejects data that is physiologically incorrect.

123. A method according to claim 122, comprising rejecting data based on a length of contraction.

124. A method according to claim 122, wherein said filter rejects data based on their derivative.

125. A method according to claim 124, wherein filtering comprises:

finding a derivative for said data;

thresholding the data; and

integrating the data.

126. A method of controlling of pharmaceutical provision to a patient in labor, comprising:

(a) providing an intervention to the patient;

(b) collecting information on geometrical changes in said patient indicating an effect of the intervention on a labor process; and

(c) selectively modifying said providing in response to said collecting with a feedback time of less than 20 minutes.

127. A method according to claim 126, wherein said feedback time is less than 10 minutes.

128. A method according to claim 126, comprising maintaining a desired range of geometrical response by said modifying.

129. A method according to claim 126, wherein said modifying comprising stopping said providing if no labor progression is generated by said intervention

130. A method according to claim 126, wherein said modifying comprising modifying said intervention to achieve a maximal individual slope for the patient.

131. A method according to claim 126, wherein said intervention comprises pharmaceutical provision.

132. A method according to claim 126, wherein said intervention comprises an instruction to change position.

133. A method according to claim 126, wherein said selectively modifying comprises automatically selectively modifying.

134. A method according to claim 126, wherein said selectively modifying comprises generating a suggestion to selectively modify.

135. Apparatus for monitoring labor, comprising:

(a) an input adapted to receive input signals from at least one monitoring system monitoring a patient in labor; and

(b) a controller configured to carry out any of the preceding methods based on the received signals.

136. Apparatus according to claim 135, comprising an instruction output which displays instructions to a patient in labor.

137. Apparatus according to claim 136, comprising a tracker adapted to track the effect of such instruction on said signals.

138. Apparatus according to claim 136, comprising a monitor adapted to monitor compliance with said instructions.

139. A method of presenting geometrical information collected during a labor process, comprising:

(a) arranging positional information from at least one cervical position and at least one fetal position in a 3D display; and

(b) arranging the display to maintain a center of gravity between positions of said sensors.

140. A method according to claim 139, comprising arranging state information on said display.

141. A method according to claim 139, comprising arranging variability information on said display.